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DERWENT-ACC-NO: 1989-173154
DERWENT-WEEK: 198924

TITLE: Conduit for motion transmitting cable - has strengthening aramid fibre winding between wire sheath and outer plastic coating

INVENTOR: FREDERIKSE, T L

PRIORITY-DATA:
1984US-0653377 September 21, 1984

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
CA 1254110 A	May 16, 1989	N/A	018	N/A

INT-CL (IPC): F16C 1/00

ABSTRACTED-PUB-NO: CA 1254110A
BASIC-ABSTRACT:

Conduit for accommodating movable motion transmitting element of motion transmitting system has an inner liner of polytetrafluoroethylene which provides an internal antifriction surface engaging and guiding the element. The liner is surrounded by a wire sheath comprising a layer of wires wound in a helical coil of predetermined pitch, the sheath accommodating tension loads. A multiple-strand winding of aramid yarn strands is helically wound around the sheath in a lower pitch and a tough, flexible sheath, made of material having memory characteristic characteristics encapsulates the aramid yarn strands.

USE/ADVANTAGE - Motion transmitting system is typically a throttle control motion-transmitting system for a motorboat, the transmitting element being attached at one end to a lever and at the other to a mounting attached to the throttle. The conduit is designed to transmit the forces involved and allow the element to slide freely even when it is bent, the conduit not becoming distorted in cross-section, changing in length, or cracking. The use of an aramid yarn winding is instrumental in enabling the conduit to resist elongation and creep fatigue.

Consumer and Corporate Affairs Canada — Consommation et Corporations Canada

(11) (A) No. 1 254 110

(45) ISSUED 890516

(52) CLASS 142-48

(51) INT. CL. ^{4} F16C 1/00

(19) (CA) CANADIAN PATENT (12)

(54) Conduit Device for a Motion-Transmitting System

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(21) APPLICATION No. 488,204

(22) FILED 850807

(30) PRIORITY DATE (US) U.S.A. (653,377) 840921

No. OF CLAIMS 6

Canada

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CCA-274 (11-82)

1254110

CONDUIT DEVICE FOR A MOTION-TRANSMITTING SYSTEM

Background

This invention relates to a conduit device and more particularly to a conduit device for a cable or other motion transmitting element.

Conduit devices for a cable or other motion transmitting element are known in the art. These devices comprise a tubular casing and are typically used to enclose a motion transmitting element such as a wire core element of a motion-transmitting system. Illustratively, in a throttle control motion-transmitting system for a motorboat, the motion transmitting element (i.e., core element) is attached at one end to a lever and at the other end to a throttle of the motor. In addition, the conduit device that surrounds the core element is attached at one end to a fulcrum of the lever and at the other end to a mounting device which mounts the throttle to the motor. Together, the conduit device and core element with lever at one end control the throttle of the motor. In particular, when the lever is pushed or pulled, the core element moves axially in the conduit device to exert a corresponding force on the throttle of the motor.

In order for a conduit device to perform adequately in such a motion-transmitting system, the conduit device must be designed to meet several performance criteria. Namely, (1) the conduit device must permit the core element to transmit substantial forces which are typically on the order of tens or hundreds of pounds. (2) The conduit device must fit loosely around the substantially inextensible and incompressible core element in order to permit the core

member to slide freely within it. In addition, (3) it must permit the core element to slide freely within it even when reasonable bends are made in the conduit device incident to its normal use. Furthermore, (4) the conduit device must be flexible, yet must not become distorted or deformed in cross section when it is bent along a reasonable radius of curvature, or lengthen or shorten when it is subjected to the forces incident to its normal use. Moreover, (5) the conduit device must not crack, stretch, deteriorate, or otherwise fail when the core element is moved back and forth under a maximum load within the conduit device. Finally, (6) the conduit device must form a substantially impervious covering about the core element to preclude the penetration of moisture, dust or any other substance which by corrosion, abrasion, or other effect impairs the freedom of movement of the core element or otherwise leads to failure of the conduit device and the core member.

To date, most conduit devices have not adequately met these performance criteria. As an illustration, one prior art conduit device comprises steel wires that are wrapped about the core element in the form of a helical coil. Although this conduit device is mechanically satisfactory in that it meets the first two performance criteria it is relatively inflexible to bending around a reasonable radius of curvature. Additionally, moisture, dust, and other foreign substances easily penetrate the outer wall of the device and impair the freedom of movement of the core element inside the device. Although an outer sheath of plastic or the like notably improves the ability of the device to resist such penetration, such

outer sheath does not, however, improve the inflexibility of the conduit device to bending around a reasonable radius of curvature.

Another drawback of this prior art conduit device is that special lubricants must be used between the core element and the conduit device in order to minimize the force that is required to initiate movement of the core element inside the conduit device, i.e., to overcome the static friction between the core element and the conduit device. In addition, once movement of the core element is initiated, these lubricants are necessary to permit the core element to continue to move freely within the steel walls of the conduit device, i.e. to minimize the dynamic friction between the core element and the conduit device.

In an attempt to improve the characteristics of these conduit devices in order to meet the above performance criteria, other methods have been devised for encasing the core element of a motion-transmitting system. In one of these devices, the conduit comprises laminations of plastic and wire. U.S. Patent No. 3,063,303, discloses one such conduit device comprising an inner liner, a wire sheath, a nylon winding, and an outer sheath. The inner liner comprises a polytetrafluoroethylene material which is commonly sold under the trademark Teflon and lies contiguous to and disposed about the outer surface of the core element. Since the surfaces of the liner have a very low coefficient of friction, the surface of the liner that lies contiguous to the outer surface of the core element eases the axial movement of the core element inside the conduit device.

The wire sheath lies contiguous to and is disposed about the outer surface of the inner liner and comprises a multiplicity of metallic wires that are wrapped about the inner liner to form a helical coil having a high pitch. The wire sheath has a high tensile strength and resistance to elongation and thus minimizes backlash in the operation of the conduit device.

The nylon winding of the patent comprises a multiplicity of nylon fibers that are wrapped about the wire sheath in the form of a helical coil having a low pitch. This winding resists any radial deformation or radial elongation of the conduit device during normal use, particularly under loads which may be imparted to bends in the conduit device by the motion transmitting core element.

Finally, the outer sheath of the patent comprises plastic material or other material having a memory characteristic which causes the material to return to its original shape after being deformed. This outer sheath maintains the inner liner, the wire sheath, and the outer winding in a fixed spatial relationship with respect to each other without substantially impairing the bending freedom of the conduit device.

Notwithstanding this construction, which meets the above performance criteria, the conduit device disclosed in that patent as well as other similar prior art devices are plagued with other problems. For example, material, fabrication, and assembly costs of these conduit devices are relatively expensive. In addition, the wire sheath in this conduit device has multiple turns of wire wrapping in order to provide the device with a high tensile strength and resistance to elongation. As a result, the turns of wire wrapping in

the wire sheath make the conduit device very heavy. Furthermore, although this conduit device does not significantly impair the movement of the core element and does not introduce significant backlash in the operation of a throttle control system, these characteristics depend upon the device being in a neutral bending position i.e., the axis along which there is no significant change in length when the cable is bent. When the conduit device is twisted, the movement of the core member is significantly impaired and backlash in the operation of the device becomes noticeable.

Some of these problems stem from using a nylon winding. Nylon lacks certain characteristics which are essential to the use of the conduit device and which must therefore be compensated by other means such as an expensive wire sheath. In particular, a nylon winding becomes distorted or deformed in cross section when it is bent along a reasonable radius of curvature. It also exhibits minimum tensile strength and resistance to elongation. Furthermore, over prolonged use, creep fatigue of the nylon winding greatly reduces the service life of the nylon winding and hence the service life of the conduit device.

Another problem with using a nylon winding is its minimal resistance to crushing or deformation forces when it is applied in firm gripping relation to the outer surface of a wire sheath. If too firmly applied, the wire sheath may cut the nylon winding. If too loosely applied, the nylon winding as well as the wire sheath may move longitudinally with respect to the inner liner. In this latter case, any movement of the wire sheath creates friction between the wire sheath and the

inner liner which deteriorates the outer surfaces of the inner liner and thereby greatly reduces the service life of the conduit device.

A nylon winding is also wanting in other physical properties-thermal properties, for example- that would permit the conduit device to be used under a variety of conditions. With respect to its poor thermal properties, when the core element is operated either in a high temperature environment or in a moderate temperature environment but under rapid fluctuations of low to high loads especially around bends over an extended period of time, the temperature of the nylon winding often approaches the melting point of nylon. The change in physical state of the nylon which is brought about by melting and then hardening of the nylon winding decreases the tensile strength and resistance to elongation of the nylon winding. On the other hand, in a low temperature environment the nylon winding becomes brittle which makes it susceptible to fatigue or facture- in short, "cracking"- during normal use.

SUMMARY

In the present invention, I have devised a conduit device for a cable or other motion transmitting element. In accordance with my invention the device comprises an inner liner, a wire sheath, an outer winding and an outer sheath.

The inner liner comprises a polytetrafluoroethylene material which is commonly sold under the trademark Teflon and lies contiguous to and disposed about the outer surface of the core element. The low coefficient of Teflon material eases the axial movement of the core element inside the conduit device.

The wire sheath of the invention lies contiguous to and is disposed about the outer surface of the inner liner and comprises a multiplicity of metallic wires that are wrapped about the inner liner in a helical coil having a high pitch. The wire sheath has a high tensile strength and resistance to elongation and thus minimizes backlash in the operation of the conduit device.

The outer winding of the invention comprises multiple-strands of aramid fibers which are commercially available from the DuPont Company under the trademark Kevlar. The multiple-strands are wrapped around the wire sheath in the form of a helical coil having a low pitch. The outer winding is wrapped tightly around the wire sheath to hold the sheath securely in firm gripping engagement with the inner liner.

Finally, the outer sheath of the invention comprises nylon material or other material having a memory characteristic that returns it to its original shape after being deformed. This outer sheath is extruded onto the outer winding and wire sheath and maintains the inner liner, the wire sheath, and the outer winding in a fixed spatial relationship with respect to each other without substantially impairing the bending freedom of the conduit device.

It is the use of Kevlar material as an outer winding in the conduit device that makes the present invention uniquely suitable for use in a motion-transmitting system. Kevlar is adequately hard and strong so that an outer winding comprising multiple-strands of Kevlar does not become distorted or deformed in cross section when bent along a reasonable radius of curvature. Kevlar also has a high tensile strength and

resistance to elongation so that an outer winding comprising Kevlar exhibits a good overall resistance to compressive, elongation, and tensile forces on the conduit device that are incident to normal use. In addition, in comparison to other prior art devices, the outer winding of the present invention is better able to resist creep fatigue and therefore has a much longer service life. This increases the service life of the conduit device.

Advantageously, Kevlar has adequate mechanical strength so that the outer liner resists crushing or deformation forces when it is applied in firm gripping engagement to the outer casings of sheath wires. Thus, the outer winding holds the wire sheath in firm gripping relation to the inner liner in order to minimize longitudinal movement between the wire sheath and the inner liner. As a result, friction between the inner liner and the contiguous wire sheath which can deteriorate the surface of the inner liner is minimized so that the service life of the conduit device is increased. Kevlar also displays a low coefficient of friction in combination with steel and other metallic elements so that if the outer winding moves longitudinally with respect to the wire sheath it does not deteriorate as rapidly as windings made of conventional materials.

Because the outer liner of the present invention advantageously provides the previously discussed physical properties, it eliminates the need to use small gage wire in the wire sheath to provide these same properties. For this reason, the outer winding makes the conduit device of this invention less expensive than conventional conduit devices. Moreover,

resistance to elongation so that an outer winding comprising Kevlar exhibits a good overall resistance to compressive, elongation, and tensile forces on the conduit device that are incident to normal use. In addition, in comparison to other prior art devices, the outer winding of the present invention is better able to resist creep fatigue and therefore has a much longer service life. This increases the service life of the conduit device.

Advantageously, Kevlar has adequate mechanical strength so that the outer liner resists crushing or deformation forces when it is applied in firm gripping engagement to the outer casings of sheath wires. Thus, the outer winding holds the wire sheath in firm gripping relation to the inner liner in order to minimize longitudinal movement between the wire sheath and the inner liner. As a result, friction between the inner liner and the contiguous wire sheath which can deteriorate the surface of the inner liner is minimized so that the service life of the conduit device is increased. Kevlar also displays a low coefficient of friction in combination with steel and other metallic elements so that if the outer winding moves longitudinally with respect to the wire sheath it does not deteriorate as rapidly as windings made of conventional materials.

Because the outer liner of the present invention advantageously provides the previously discussed physical properties, it eliminates the need to use small gage wire in the wire sheath to provide these same properties. For this reason, the outer winding makes the conduit device of this invention less expensive than conventional conduit devices. Moreover,

the low cost of Kevlar material in the outer winding of this invention further reduces the cost of the conduit device.

An outer winding comprising Kevlar can tolerate temperatures up to 350°F which is higher than a conduit device normally experiences when the core element is operated either in a high temperature environment or in a moderate temperature environment but under rapid fluctuations of low to high loads especially around bends over an extended period of time. In addition, an outer sheath of plastic can be extruded onto the Kevlar winding and the outer surface of the wire sheath without altering the unique physical properties that the Kevlar material provides the conduit device. The Kevlar outer winding also retains its physical properties at temperatures as low as -50°F. Thus, the Kevlar winding does not become brittle and susceptible to fatigue or fracture when the conduit device is used in adverse cold environments.

<u>Brief Description of the Drawing</u>

As shown in fragmentary perspective view in the drawing, motion-transmitting system 20 comprises flexible wire core element 22 and conduit device 23 of the present invention. Wire core element 22 comprises a stranded cable of steel or other metallic wires.

The core element is contained by conduit device 23 comprising inner liner 24, wire sheath 26, outer winding 28, and outer sheath 30. Inner liner 24 comprises a tube of Teflon material. The inner liner has a moderate wall thickness and has an inside diameter which is slightly larger than the outside diameter of core element 22 so that the core element slides freely

inside inner liner 24. In addition, since the surfaces of the liner have a very low coefficient of friction, the surface of the liner that lies contiguous to the outer surface of the core element eases the axial movement of the core element inside the liner.

Wire sheath 26 comprises a multiplicity of steel or other metallic wires that are wrapped about inner liner 24 in the form of a helical coil having a high pitch. The wire sheath accommodates tension loads in the conduit device. In particular, it provides the conduit device with a high tensile strength and resistance to elongation, which minimizes backlash effects in the operation of the conduit device. Typically, the wires are wrapped tightly about inner liner 24 in order to prevent the wires from moving relative to the inner liner along the axis of the motion-transmitting system or spreading with respect to each other. Such a tight wire wrapping increases the service life of the conduit device. Advantageously, inner liner 24 permits such a tight wire wrapping about the inner liner. However, although the wires are wrapped in a firm gripping relation about the inner liner, the wire sheath does permit small, localized movements between adjacent wires of the sheath which normally occur when the cable assembly is bent. As a result, the wire sheath also provides the cable device with some bending flexibility.

Outer winding 28 comprises multiple-strands of aramid fiber which in the preferred embodiment are commercially available from the DuPont Company under the trademark Kevlar. These Kevlar strands are wrapped about wire sheath 26 in the form of a helical coil having a low pitch. The outer winding is wrapped tightly about the wire sheath to hold the sheath

securely in firm gripping engagement with inner liner 24. With respect to the wire sheath and the inner liner, such out winding undergoes very little axial change in length when the conduit device is bent. As a result, it securely grips the wire sheath and inner liner over the entire length of the motion-transmitting system without impairing the bending freedom of the conduit device.

Kevlar material is almost unique in its suitability for use as an outer winding in a motion-transmitting system. Numerous other plastic compositions in tubing form have been found wanting in one or more of the properties previously discussed in the Background which are especially desirable for heavy duty conduit devices. Some of these, such as nylon or a soft plastic, are too soft for general use and are quickly cut through by the longitudinal movement of the core element when the core element transmits heavy loads around bends in the cable assembly. Others, such as a hard resin or a hard plastic, are undesirably stiff and brittle for use with a cable assembly having the degree of flexibility generally required in a motion-transmitting system. Still others, such as wires or metals, display a high coefficient of friction when they are contiguous to and move ever so slightly along a wire sheath.

Kevlar, however, possesses an excellent combination of properties for use as an outer winding in a conduit device. Kevlar is adequately hard and strong so that an outer winding comprising multiple-strands of Kevlar does not become distorted or deformed in cross section when it is bent along a reasonable radius of curvature. As a result, the conduit device resists large forces that are applied to the outer winding by

the core member as it transmits a heavy load around bends in the motion-transmitting system. Kevlar also has a high tensile strength and resistance to elongation so that an outer winding comprising Kevlar exhibits a good overall resistance to compressive, elongation, and tensile forces on the conduit device that are incident to normal use. In addition, in comparison to other prior art devices, the outer winding of the present invention is better able to resist creep fatigue and therefore has a much longer service life. This increase the service life of the conduit device.

Advantageously, Kevlar has adequate mechanical strength so that the outer winding resists crushing or deformation forces when it is applied in firm gripping engagement to the outer casing of sheath wire. Thus, the outer liner holds the wire sheath in firm gripping relation to the inner liner in order to minimize longitudinal movement between the wire sheath and the inner liner. As a result, friction between the inner liner and the wire sheath which can deteriorate the surface of the inner liner is minimized so that the service life of the conduit device is increased. Kevlar also displays a low coefficient of friction in combination with the wire sheath so that if it does move longitudinally with respect to the wire sheath, it does not deteriorate as rapidly as windings made of conventional materials.

Because the outer liner of the present invention advantageously provides the previously discussed physical properties, it eliminates the need to use small gage wire in the wire sheath to provide these same properties. For this reason, the outer winding makes the conduit device of this invention less

expensive than conventional conduit devices. Moreover, the low cost of Kevlar material in the outer winding further reduces the cost of the conduit device.

An outer winding comprising Kevlar can tolerate temperatures up to 350°F which is higher than a conduit device normally experiences either in a high temperature environment or in a moderate temperature environment but when the core element is operated under rapid fluctuations of low to high loads especially around bends over an extended period of time. In addition, an outer sheath of plastic can be melted onto the Kevlar winding and the outer surface of the wire sheath without altering the unique physical properties that the Kevlar material provides the conduit device. The Kevlar outer winding also retains its physical properties at temperatures as low as -50°F. Thus, the Kevlar winding does not become brittle and susceptible to fatigue or fracture when the conduit device is used in adverse cold environment.

Outer sheath 30 comprises a tube of plastic material that is engaged over outer winding 28 and desirably extends over the entire portion of the wire sheath. This tube of plastic is extruded onto the Kevlar winding and wire sheath in order to tailor the fit of the outer sheath to the outer surface of the wire sheath and the outer winding. The outer sheath maintains outer winding 28, wire sheath 26, and inner liner 24 in fixed spatial relationship with each other without impairing the bending freedom of the conduit device. Outer sheath 30 also assists the outer winding of Kevlar to accommodate compression loads in a manner which minimizes losses in operating efficiency as a result of backlash. Although plastic is used in the preferred embodiment, any material having a memory

characteristic which causes the material to return to its original shape after being deformed is suitable material for the outer sheath. Advantageously, this material permits the cable assembly to be stored in a coiled condition and subsequently returned to its extended, straight condition when installed in a motorboat or other control system.

While the invention has been described in conjunction with specific embodiments, it is evident that numerous alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description.

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In motion transmitting system, a movable motion transmitting element and a conduit device for accommodating said movable motion transmitting element, said conduit device comprising an inner liner of polytetrafluoroethylene material extending the length of said motion transmitting element and providing an internal antifriction surface for engaging and guiding the motion transmitting element; a wire sheath comprising a layer of wires wound in a helical coil having a predetermined pitch around an outer surface of said inner liner for accommodating tension loads; a multiple-strand winding of aramid yarn strands that is helically wound in a lower pitch than said wire sheath around an outer surface of said wire sheath; and a tough, flexible sheath comprising material having memory characteristics, said sheath lying contiguous to and disposed about an outer surface of said multiple-strand winding of aramid yarn strands.

2. In a cable assembly for a motion transmitting system, a movable motion transmitting element and a conduit device for accommodating said movable motion transmitting element, said conduit device comprising an inner liner of polytetrafluoroethylene material extending the length of said motion transmitting element and providing an internal antifriction surface for engaging and guiding the motion transmitting element; a wire sheath comprising a layer of wires wound in a helical coil, having a a high pitch around an outer surface of said inner liner for accommodating tension loads; a multiple-strand winding of aramid yarn strands that is helically wound in a low

pitch around an outer surface of said wire sheath; and a tough, flexible sheath comprising material having memory characteristics, said sheath lying contiguous to and disposed about an outer surface of said multiple-strand winding of aramid yarn strands.

3. The motion-transmitting system of claim 1 wherein said multiple-strand winding of aramid yarn strands has a higher extrusion temperature than said tough, flexible sheath surrounding the outer surface of said winding.

4. The motion-transmitting system of claim 2 wherein said multiple-strand winding of aramid yarn strands has a higher extrusion temperature than said tough, flexible sheath surrounding the outer surface of said winding.

5. The motion-transmitting system of claim 1 wherein said flexible sheath of material having memory characteristics comprises plastic.

6. The motion-transmitting system of claim 2 wherein said flexible sheath of material having memory characteristics comprises plastic.

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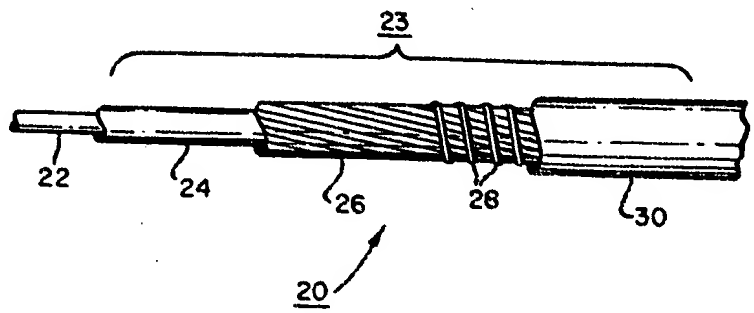

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